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ABSTRACT

A difficult task in creating rich, exploratory interactive learning environments is building an environment that is truly engaging. Engagement can be defined as the nexus of intrinsic knowledge and/or interest and external stimuli that promote the initial interest in, and continued use of a computer-based learning environment. Complete and total involvement in a given task is described by Csikszentmihalyi's Flow Theory. Flow Theory defines the difference between enjoyment and pleasure; an optimal experience is more of a manifestation of the former. The following elements of flow are manifested in computer games and learning environments: (1) task that can be completed; (2) ability to concentrate on task; (3) task has clear goals; (4) task provides immediate feedback; (5) deep but effortless involvement; (6) exercising a sense of control over actions; (7) concern for self disappears during flow, but sense of self is stronger after flow activity; and (8) sense of duration of time is altered. The quality of multimedia assets such as images, sounds, and animations, are a key factor in interesting users in a computer game; this is an important issue in the design and development of educational software. A table shows the relationships among flow, games, and design of computer-based learning environments. Contains 14 references. (AEF)

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Creating Electronic Learning Environments: Games, Flow, and the User Interface

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Creating Electronic Learning Environments: Games, Flow, and the User Interface

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Defining an environment

As computer technology increases in sophistication, so does our ability to provide users with more sophisticated learning and performance environments. Advances in the conception of computer-based environments have included Gery's (1991) notion of electronic performance support systems (EPSS), and Hannafin's (1992) description of the importance of computer-based learning environments (CBLE). CBLE's are intended to be a logical progression of our knowledge of learning theory and the capabilities of today's computer systems.

Creating a learning environment is not easy. Hannafin (1992) says that the learning environment should be a comprehensive integrated system that promotes the engagement of the learner, provides for the manipulation of information contained in a variety of media centered around a specific learning theme, and be a rich, exploratory, interactive environment. Reiber (1996) adds the important element of the learning environment being self regulated by the learner. Finding media that is centered around, or supports a particular learning theme is not difficult to do. Creating rich, exploratory interactive environments, while difficult, is not impossible. The singularly difficult task is building an environment that is truly engaging.

What is engagement?

Defining engagement is difficult because of its tendency to be relative to a particular task. There are various types of engagement. In a CBLE we are referring to the notion that the program makes the learner want to be there. There may be many reason why the learner chooses to be there. The ARCS model (Keller, 1983; 1988) offers a detailed discussion of the varying elements in the learners' motivation to learn. One reason learners choose to work in a learning environment may be that they are simply interested in the content. Interest in the content, or having a well defined question, provides the learner with intrinsic motivation to be working within the environment. Learners with intrinsic motivation may also be said to be exhibiting epistemic curiosity (Gagne, 1985). Epistemic curiosity is often caused by incongruous ideas, beliefs or attitudes about a subject, which is to say, curiosity based on lack of knowledge about a particular problem. A learner who is internally motivated may find that something as generic as a multi-media encyclopedia could serve as a learning environment. The motivation comes from within the learner, and the environment itself does not necessarily need to be engaging beyond its ability to present the content in a factual manner. If, however, the learner is not intrinsically motivated, then the environment may need to offer greater motivational features to keep the learner interested. It is not unrealistic to imagine that every learner may exhibit intrinsic motivation, and require extrinsic motivational features during the life span of the learning process, or while they are working within the learning environment. Therefore, I am defining engagement here as the nexus of intrinsic knowledge and or interest and external stimuli that promote the initial interest in, and continued use of a computer-based learning environment.

Flow Theory

Complete and total involvement in a given task is defined and described by Csikszentmihalyi's Flow Theory (Csikszentmihalyi, 1990). Flow theory is described as the feeling of optimal experience. It is felt when "...instead of being buffeted by anonymous forces, we do feel in control of our own fate. ...we feel a sense of exhilaration, a deep sense of enjoyment ... (Csikszentmihalyi, 1990, page 3). In order to reach this state of optimal experience: "There must be a goal in a symbolic domain; there have to be rules, a goal, and a way of obtaining feedback. One must be able to concentrate and interact with the opportunities at a level commensurate with one's skills" (Csikszentmihalyi, 1990, page 118). Flow is often experienced during physical activities because of the ability to realize the manifestations of the requirements of a flow experience. For many people finding a moment of *flow* can be when they are doing things that they enjoy and excel at, although flow can be experienced by nearly anyone when they are competing in an environment that is appropriate to their skills. Basketball players, even poor ones like myself, report games when everything you throw up goes in. It is when it is your day, when you are so

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totally engrossed in your activity that you lose yourself for the duration of the activity. You are in *the zone*. Though I might experience that zone on the playground with people at my own skill level, I am not likely to experience flow in a pick up game with NBA All Stars. The reason for this is that despite the fact that my level of play might rise to the occasion, it would never rise far enough for me to feel comfortable. The zone can be explained through flow theory. While flow is often experienced during physical activities, it occurs for different people during different activities, and has been documented to occur during the learning process. Most often flow in learning occurs at times when outside forces do not dictate what is to be learned (Csikszentmihalyi, 1990). When people are intrinsically motivated, they find themselves able to "read for hours" or "pull an all nighter" to master the content. But what happens during environments where there is no intrinsic motivation? Is it possible to provide learners in a contrived environment with the necessary tools to reach a state of flow in order to optimize the learning experience?

Video Arcades and Learning

As an undergraduate in 1983 I watched my college friends get in the zone with computer games. People standing in front of a video game console would flex their hands, stretch their shoulders to loosen up to play a video game. Once in the game, they could be in a Zen-like state of complete attachment to the task at hand. Never mind that the task was silly. Never mind that they themselves would likely never pilot a space ship and face legions of attacking aliens. Never mind the fact that all of the rules were arbitrary and contrived by someone else—they played these games. They learned every subtle nuance of the games. They often knew more about the games than they ever knew about the classes they were taking. Despite the fact that there was no authentic problem for them to solve, they found themselves completely engrossed in the task.

During studies of games (Jones, 1997) I reported that certain games engrossed people so totally that they could not stop playing. Herz (1997) describes well the intense fascination people find in computer games. It is not just the ability to play, to face danger, death, and ultimate mayhem and still come out alive. It is not solely about competition. It is about the intense feelings of engagement that a "good" game can instill in the player. In previous and ongoing studies of computer games and gamers, I have heard stories of people who played *Myst* for an entire weekend, ignoring the need to sleep in order to solve the puzzles. I have spoken with people who can tell within the first few minutes of starting a game whether or not they will play a particular game well. "I don't have the feeling today," was the comment of one gamer. There exists among many people who play games an ability to become completely in touch with one's self and one's abilities. This is due in part to one's ability, and in part due to the fact that there exists within people strong, tangible feelings of attachment to the games they play. These games engender deep feelings. Good games rock; bad games suck. One of the key reasons that a game can foster this kind of devotion is that good games tend to the total package. It is not just the graphics, sounds, and other multi media assets they use. It is about how those assets help define, support, and give life to a domain that has no counterpart in the physical world. They draw you in and make you believe. *Doom* and *Doom II* were so frightening to some players that they refused to go into the labyrinth (i.e. play the game) again (Herz, 1997). That is a powerful statement. These are truly immersive environments that support the eight major components of the flow experience. This is demonstrated in Table 1.

Enjoyment and Pleasure

Within Flow Theory, Csikzentmihalyi (1990) defines the difference between enjoyment and pleasure. Enjoyment is characterized by the feeling of forward movement, or a sense of accomplishment. Pleasure can give enjoyment and can even contribute to enjoyment. However, pleasure is defined as being passive in nature, while enjoyment requires direct participation by an individual. An optimal experience is more of a manifestation of enjoyment than pleasure. Being active in the experience tends to promote enjoyment. It is analogous to the difference of watching somebody playing basketball and playing yourself. The former is nice to watch, but the latter gives you a greater feeling of accomplishment.

Table 1. Components of flow as manifested in computer games.

Element of Flow	Manifestation in a game
1. Task that we can complete	The use of levels in a game provide small sections that lead to the completion of the entire task
2. Ability to concentrate on task	Creation of convincing worlds that draw users in. The Dungeons and Labyrinths in Doom II help you suspend your belief systems for a time.
3. Task has clear goals	Survival, collection of points, gathering of objects and artifacts, solving the puzzle
4. Task provides immediate feedback	Shoot people and they die. Find a clue, and you can put it in your bag.
5. Deep but effortless involvement (losing awareness of worry and frustration of everyday)	The creation of environments that are far removed from what we know to be real helps suspend belief systems and take one away from the ordinary
6. Exercising a sense of control over their actions	Mastering the controls of the game, such as mouse movement or keyboard combinations
7. Concern for self disappears during flow, but sense of self is stronger after flow activity	Many games provide for an environment that is a simulation of life and death. One can cheat death and not really die. People stay up all night to play these games. It is the creation of an integration of presentation, problem, and control over the system that promotes this.
8. Sense of duration of time is altered.	Years can be played out in hours. Battles can be conducted in minutes. The key point is that people can stay up all night playing these games.

In computer games, certain features provide pleasure: good graphics, nice music, visual effects, and interesting animations are aesthetically pleasing, but do not necessarily contribute to creating a good game. What makes a game "good" is a good problem that is manifested appropriately. It does not matter if it is rendered elegantly, but that it is rendered in a manner consistent with the problem. Herz (1997) presents convincing arguments that graphically minimal games of the late 1970's and early 1980's (such as *Tempest* and *Pac Man*) were actually more engaging than more recent games that provide a much greater level of graphic detail. Much of this has to do with the problem facing the user and how it is manifested. Problems that have meaning, that stretch one's abilities to the limits are more likely to provide feelings of flow than easy problems: we like to be challenged. If we are to relate this notion to the development of learning environments, it might suggest that we need to help the learner define a problem within the environment, or that perhaps the environment itself could represent a manifestation of a problem. This might be accomplished by building tools into the learning environment that help learners solve a problem. Even drill and practice activities can help maintain a level of involvement on the part of the learners.

Cognition and Flow

It might be argued that one could make a relationship between cognition and flow as it relates to CBLE's. Norman (1993) speaks of two kinds of cognition: experiential and reflective. Experiential cognition is one where one may react to events efficiently and effortlessly. An example of this would be the way people who play action games such as *Doom II* exhibit this type of cognition. It is a combination of skill, reflexes, and knowledge that comes together after many hours of practice. Reflective cognition is that of comparison and contrast of thought, of decision making. It is the type of cognition that leads to new ideas and novel responses. Strategy games, such as *Warcraft II*, or puzzle games such as *Myst*, require the use of this type of cognition. In working with complex tasks, it is usually necessary to combine both reflective and experiential cognition to solve problems. It is likely that in order to reach flow that one must use both types of cognition. One would need efficient, seemingly effortless skills

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related to one's ability level (experiential cognition) and the ability to assimilate and accommodate new information (reflective cognition) in order to do most activities well enough to reach a state of flow.

Relating these ideas to the design of a CBLE may mean that lack of attention to aesthetics may make a program less likely to be used, but mere inclusion of aesthetically pleasing elements does not guarantee that the elements will promote learning, or add to the enjoyment of the program. Pleasure can be had or developed through seductive bells and whistles that are added on to a program. Enjoyment might occur because the bells and whistles were used as intentional pieces of the environment. The bells and whistles, or multi-media assets, employed in an environment should be used to promote the workings of the environment. Music that is used in games can help underscore emotions. The fast, hard pounding music in *Doom II* causes one's adrenaline to increase in an action game, where as the ephemeral background music in *Myst* helps enrich the feeling of mystery. Beyond the ability of the multi-media assets to support enjoyment by helping to support or carry forth a consistent tone, enjoyment can only be had when there is some conflict between what you know, and what you want to know, which is the essential component of cognitive conflict (Piaget, 1980; Gagne, 1985). Cognitive conflict stretches our desire to know and do more. It is a confrontation between the learners' current knowledge and the learners' expectations or ambitions. It is the challenge needed to begin flow experience. A possible way to build this conflict into a CBLE is through the use of environmental juxtaposition.

Building an environment

When thinking of a learning environment, I prefer to work with Reiber's notion of an endogenous learning environment (Reiber, 1996). In these environments, the content and its structure are so closely related that "one cannot tell where the content stops and the game begins" (Reiber, 1996, page 50). One place where this notion of endogenous environments is most notable is in the area of commercial computer games. The games themselves are motivating, and weave a fabric of content and fantasy so seamlessly that one can become lost in the game for hours.

Environmental Juxtaposition

Much of the content of a computer-based learning environment is presented visually, and surrounded by or supported by some type of theme. Visually, an endogenous environment strives for seamless integration of the program's theme, content, and the patterns of interaction used in the game or other type of environment. The original pattern of interaction in a computer game was that of slide and shoot. Your agent in the game resided on a horizontal plain, and moved left to right while attacking agents moved on a vertical plain. This was begun in *Space Invaders*, and can still be seen, though more elegantly rendered, in current games such as *Mortal Kombat*. This interaction pattern has grown into a roam and shoot pattern of interaction. No longer must you wait for the enemy to come to you: now you can go out and hunt them down. *Myst* defined a new pattern of interaction. You search for clues within an environment. These clues help not only to solve the puzzle, but to figure out how the world works as well. Typically, when moving within a game, the game's controls work in concert with the game's content to provide a seamless integration of content and control. This is a good thing. However, it is sometimes desirable to impose some type of juxtaposition on the environment, and ultimately the learner.

Occasional juxtaposition or conflict within the user interface can keep people moving and engaged. The Monty Python games are excellent examples of this. In *Monty Python's Quest for the Holy Grail*, unexpected surprises keep the users engaged. However, one might argue that Monty Python products would not be complete without significant juxtaposition between the environment you are in and the surprises they throw at you.

Juxtaposition integrated between content and control might suggest that stimulus and response is not all that bad of an idea in a computer-based learning environment. Early computer-based instructional programs were often criticized as being electronic page turners. They did not engage the learner at a level beyond passive viewing. Learners need to be engaged in the educational process, and actively engaged in the content and the business of learning. Learners should be doing things in the software. Clicking on timelines, accessing pop-up text or graphics, clicking and dragging objects are all examples of active techniques used in CBLE's. Additionally building tools within the learning environment extend the notion of educational software to the arena of application software. Instead of being simply a reference tool, the software becomes a tool for calculating, comparing, and generally working on a problem. *Investigating Lake Iluca* , a multi-media learning environment created at the University of Wollongong, Wollongong , Australia, was one of the first pieces of software I saw that did this (See Figure 1).

Tools were there for testing soil and water, notebooks were there for learners to write down notes and store information to study later. These tools take away from the visual consistency of the program. In a two dimensional environment that is displayed on a computer screen, it is necessary to treat different locations through the

functionality of multiple windows. The tools work on the lake, but the tool pallete can cover other areas of the screen. However, the juxtaposition they provide is pedagogically significant, relatively seamless, and ultimately helpful and not distracting (See Figure 1).

In contrast, a *Doom* like simulation of a banking computer-based training program is juxtaposition that fails. Filipczak (1997) describes a Doom like environment where the main character must catch "clients" running around on the screen and shoot monsters (which represent clients' problems) (see figure 2).

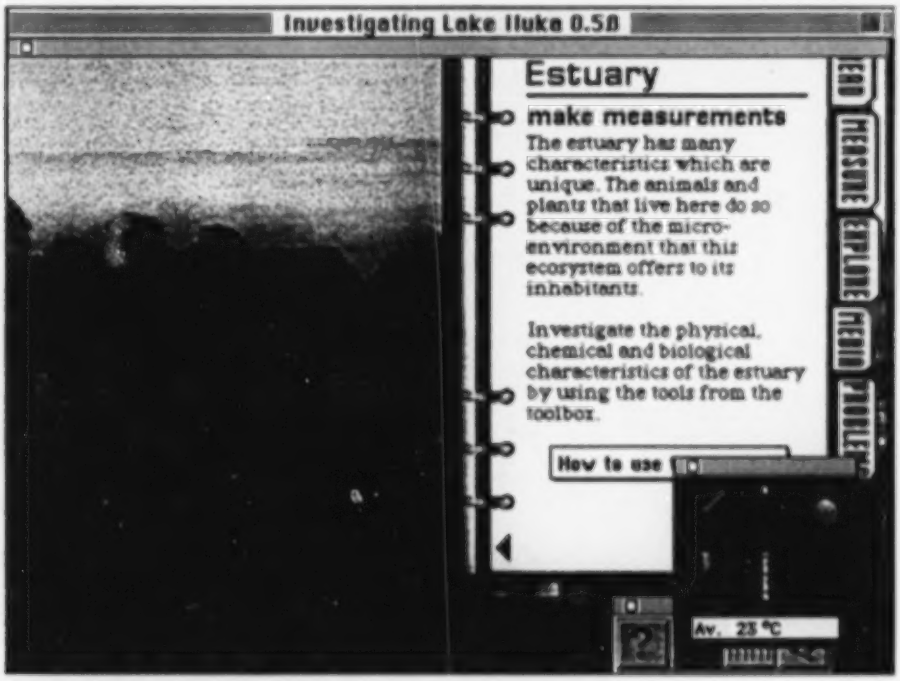
Investigating Lake Iluka 0.5B
Estuary
make measurements
The estuary has many characteristics which are unique. The animals and plants that live here do so because of the micro-environment that this ecosystem offers to its inhabitants.
Investigate the physical, chemical and biological characteristics of the estuary by using the tools from the toolbox.
How to use
Av. 25 °C
HELP
MEASURE
EXPLORE
MAIN
ROUTER

Figure 1. Tools from Investigating Lake Iluca.

When you catch a client, you are then taken to a multiple choice question screen where you must answer a policy question. If you get the question correct, you can continue playing. If you don't, then you must return to a "traditional CBT tutorial" to study the fact. I must confess that I have not seen this, and have only read its description. But if I understand this correctly, then the game is not part of the training, and the training is not part of the game. The game, as stated in this online article "...rides along with the course serving two functions: It relieves boredom by letting students take a break from the self-paced instruction; and it serves as a motivator/refresher, giving students an immediate reason to study and recall the information, and a reward when they do." From this description, it sounds like a classic example of something not to do. It is "gamus interuptus." An environment such as this could never engender flow because the environment would be constantly interrupted by switching between instruction, game, and test. It is not that it is impossible to do, but it may be that Doom is simply an inappropriate model to follow for the training. An integrated environment could engender flow. In order to have an integrated environment, one must consider carefully an integration of the content, the controls, and the patterns of interaction. In the Doom like simulation described, there are in fact three patterns of interaction. One is the traditional CBT, the second is the game, and the third is the multiple choice questions. While some juxtaposition might keep users on task and alert, this is simply far too much juxtaposition of content and patterns of interaction.

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Figure 2. Rendering of the Doom-like game from Training Magazine.

Building an Environment that uses games to engender Flow

Attention to detail

One thing seems to be abundantly clear in planning and building these types of environments: neatness counts. The quality of the multi-media assets such as images, sounds, and animations, are a key factor in getting people interested in the game, and interested in playing the game. This is an important issue to be considered in the design and development of educational software. Rather than "settling" for assets, we should be working to find appropriate, quality images and sounds to make learning environments richer, and ultimately more meaningful and enjoyable experiences. However, it is important to note that while attention to detail is important, they should have a purpose to them. As one participant in a previous study stated, "I don't know why they put those (video clips) in there. Probably because they could." Some features were included in games that while technically impressive, had no real relationship to the environment created. This is true in many pieces of educational software as well. Pushing the envelope is a noble ambition (Jones, Farquhar, & Surry, 1995), but pushing the envelope should be done relative to the environment itself, and not simply because it is possible. Figure 3 shows an example of a Main Menu within a learning environment on the saxophone. The environment itself is striving for a "cool" tone. In order to draw the users into the program, it plays upon the learners knowledge of the saxophone as a jazz instrument. The program seeks to establish a tone similar to that of a Jazz Club. The main menu then becomes a "set list," and many of the other controls and features of the program take on the tone of "cool jazz." From background graphics and music to buttons, having this supportive theme helps carry forward the theme. Additionally, it creates an environment where control and content work together.

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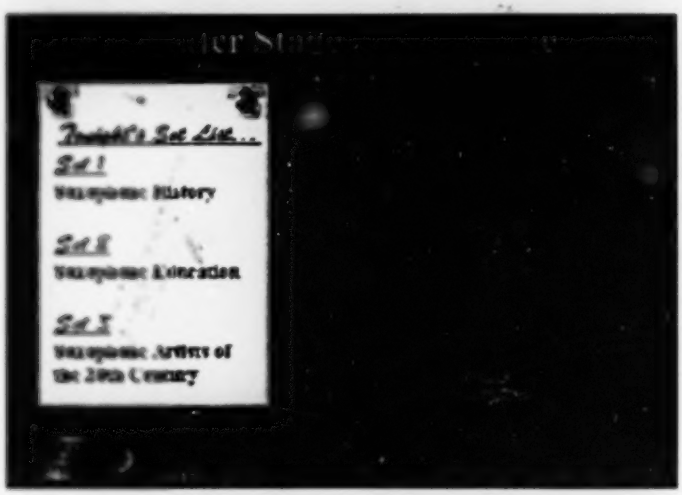

Figure 3. Use of multiple assets to create an environment. Jazz music runs in the background.

Applying Experiential and Reflective Cognition

Strategy games are ones in which the user must employ higher order thinking skills and problem solving skills to continue playing and win the game. This supports the notion of reflective cognition set forth by Norman (1993). Twitch games, also called *Thumb Candy* (Herz, 1997), are games in which the user must react quickly to circumstances, usually by killing someone, to continue playing and win the game. *SimCity* and *War Craft II* are immediate examples of strategy games, while games like *Doom* are consummate twitch games. The advantage to a twitch game is that the movement is quick, and the feedback immediate. This works to keep the user actively engaged. However the level of this engagement is often superficial. It does not typically engage one beyond the most basic level of seeing, pointing, and clicking. Strategy games require the user to look at the larger problem, and plan a strategy to solve the problem. In some games, such as *SimCity*, the results of your decisions are not immediately recognized. You must have a fair amount of internal motivation to stay with the game to realize the fruits of your labor. While twitch games offer immediate results of your work, strategy games appear to offer a greater feeling of accomplishment and satisfaction. One participant who was playing *War Craft* praised the combination of "twitch and strategy." While they ultimately liked working on complex problems in an environment, they also appreciated the sheer visceral rush of immediate feedback. One manifestation of this in a CBLE might be seen in Figure 4. In a program dealing with primary colors for pre-readers, users interact with the content by clicking and dragging, one of the most common methods of interaction on the computer. They are given paint brushes to drag on to a picture. If the correct brushes are used to create the correct color combination, then the paintbrushes change color, and the learner "paints" the picture the correct color. The controls in this exercise are indistinguishable from the content of the program, and the method of interaction, though common, serves to engage the learner both physically and intellectually.

From Games to Flow

Returning to the table that relates elements of flow to manifestations in a computer game, what follows is an effort to show possible manifestations of flow activities in a CBLE.

Conclusions

Simply put, when an individual is in a state of flow, they lose themselves. When an individual is engaged in a CBLE, they are engaged in the process of learning. It is conceivable that attending to the visual and aesthetic sensibilities of an environment can make it more engaging. It has been suggested here that certain aspects of the flow experience can be manifested in CBLE. By looking to computer games, which are engaging computer-based environments, one can possibly ferret out principles for engagement. Suggestions for incorporating gaming practices have been set forth by Jones (1997). The idea of combining flow theory with the design of computer-based learning environments is an area that is should be considered for further study.

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Figure 4. Use of tools to engage the learner in a CBLE.

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Table 2. Relationship between Flow, games, and design of CBLE's.

Element of Flow	Manifestation in a game	Possible manifestation in a CBLE
1. Task that we can complete	The use of levels in a game provide small sections that lead to the completion of the entire task	Exercises relevant to the content area that provide "drill and practice" types of activities might provide learners with areas of skill to focus on. Also aids in reinforcement.
2. Ability to concentrate on task	Creation of convincing worlds that draw users in. The Dungeons and Labyrinths in Doom II help you suspend your belief systems for a time.	Creation of seamless integration of tools, tasks, and presentation of information.
3. Task has clear goals	Survival, collection of points, gathering of objects and artifacts, solving the puzzle	Provide problems within a learning environment. Despite the desire to have learners determine their own problems, it can help to have initial problems identified for them.
4. Task provides immediate feedback	Shoot people and they die. Find a clue, and you can put it in your bag.	Combining appropriate tools with the software can provide users with mechanisms for meeting goals and gaining feedback from the software (See Figure 1).
5. Deep but effortless involvement (losing awareness of worry and frustration of everyday)	The creation of environments that are far removed from what we know to be real helps suspend belief systems and take one away from the ordinary	Keeping the visual appearance of the environment can maintain consistency which may help keep users focused on the task at hand. Less environmental juxtaposition may help keep users focused (See Figure 3).
6. Exercising a sense of control over their actions	Mastering the controls of the game, such as mouse movement of keyboard combinations	Providing for more direct control by the learner. More learner directed movement than designer determined paths.
7. Concern for self disappears during flow, but sense of self is stronger after flow activity	Many games provide for an environment that is a simulation of life and death. One can cheat death and not really die. People stay up all night to play these games. It is the creation of an integration of presentation, problem, and control over the system that promotes this.	Tools that promote self confidence (achievable goals, tasks that are level appropriate) can help strengthen sense of self and help generate greater self efficacy (See Figure 4).
8. Sense of duration of time is altered.	Years can be played out in hours. Battles can be conducted in minutes.	Chunking of information can help keep people moving. Closure (Jones Okey, 1995) can keep users working.

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